
USGS
SCRIPPS INSTITUTION OF OCEANOGRAPHY
CEC's California Climate Change Center
Translating Climate Change Uncertainties into Impacts Uncertainties
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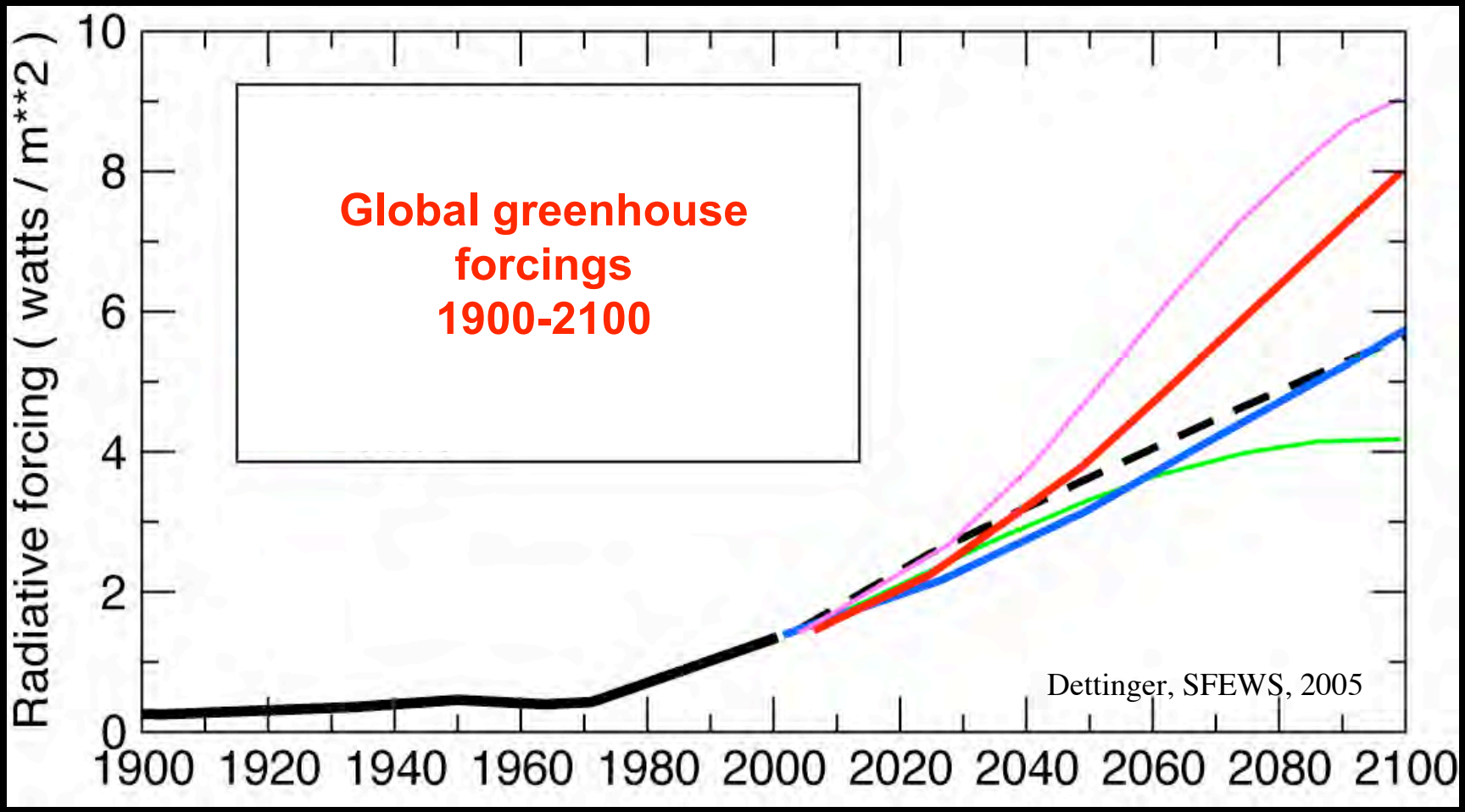
Scripps Institution of Oceanography
HETCH HETCHY 1977

When viewed in terms of radiative effects, it is clear we are now 35 years into the most serious phase of our greenhouse "experiment".



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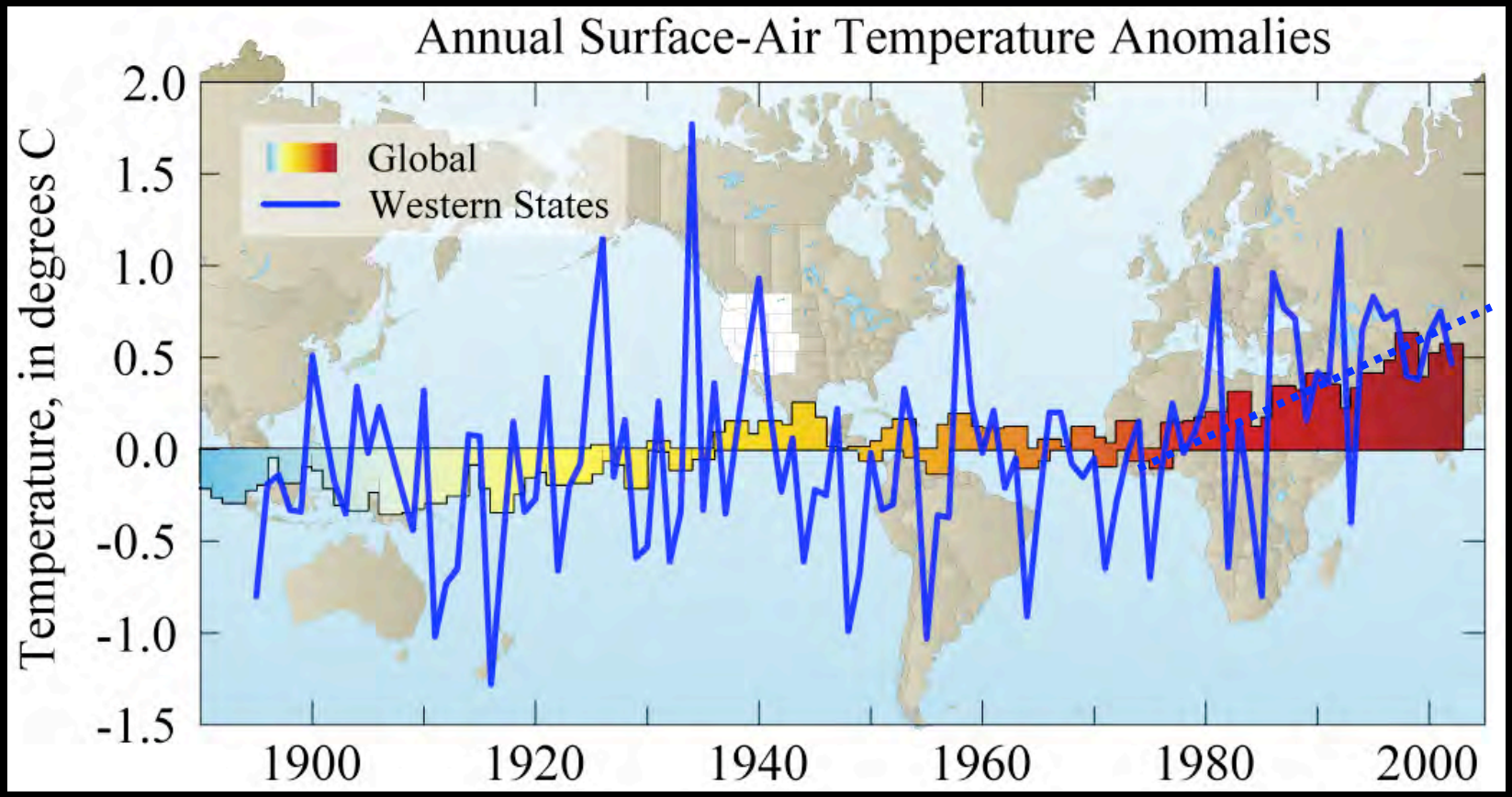
Global and western air temperatures have warmed notably in response, so that we are now regularly at the upper bounds of natural variability & remaining uncertainties.



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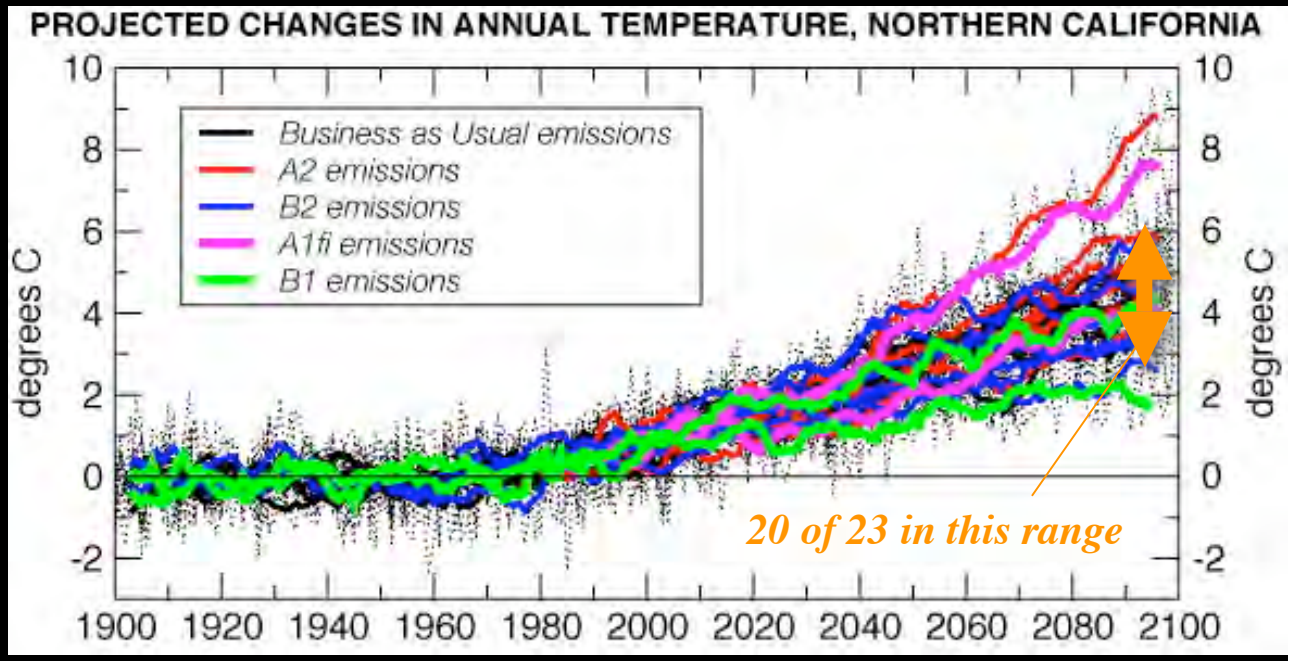
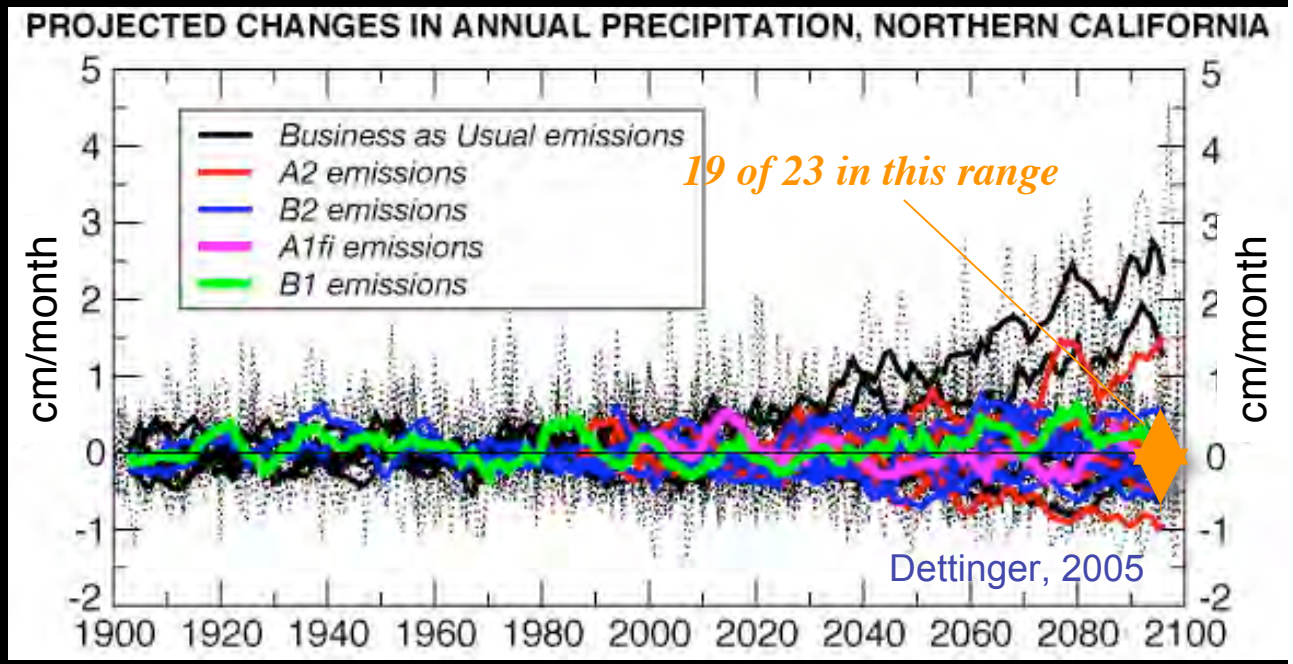
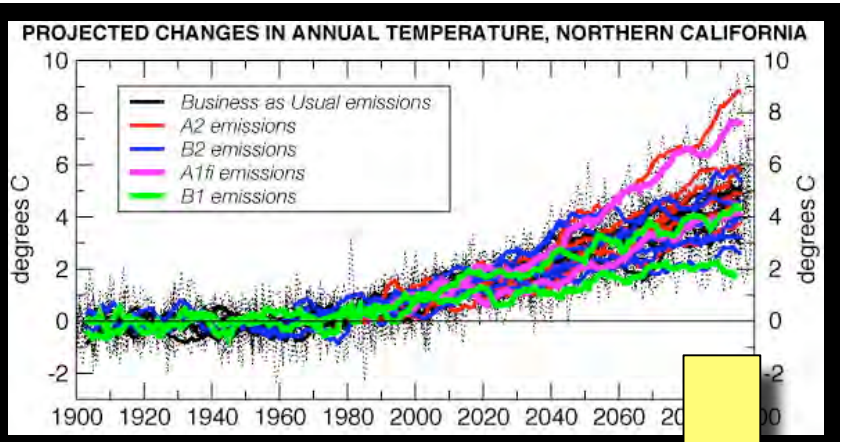
Under various greenhouse forcings, climate models continue these trends with a range of warming trends and a tendency for small annual-precipitation changes in California & most of the West amidst much scatter.

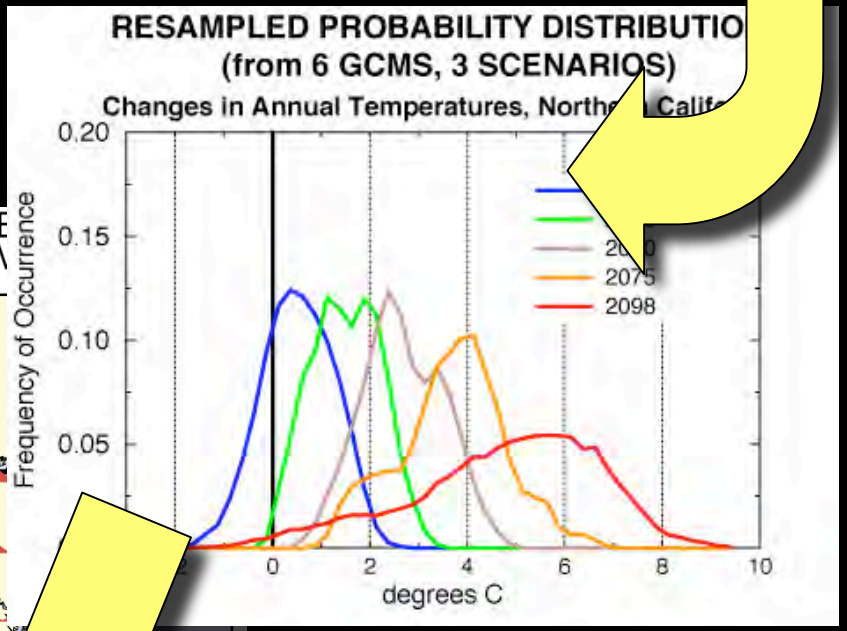


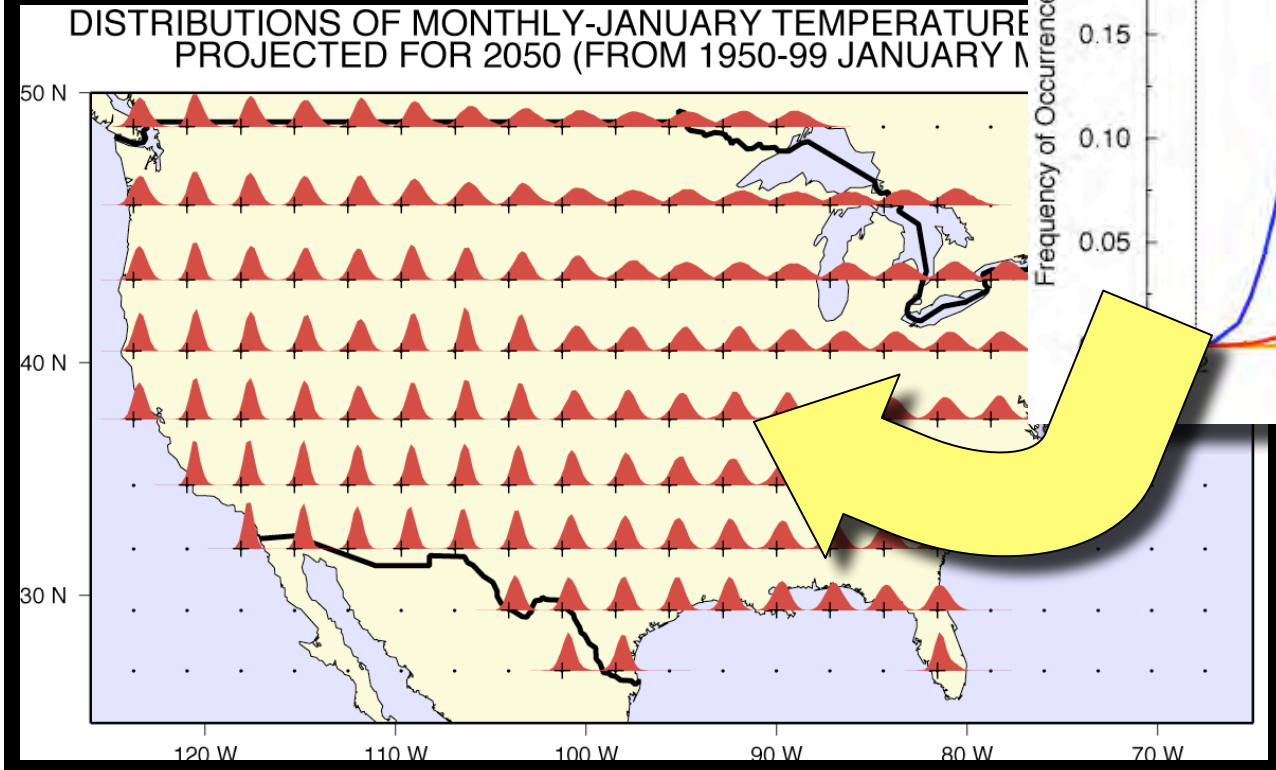


With all these projections becoming available, a natural step is to estimate **probabilities of CLIMATE CHANGE from the burgeoning projection ensembles**

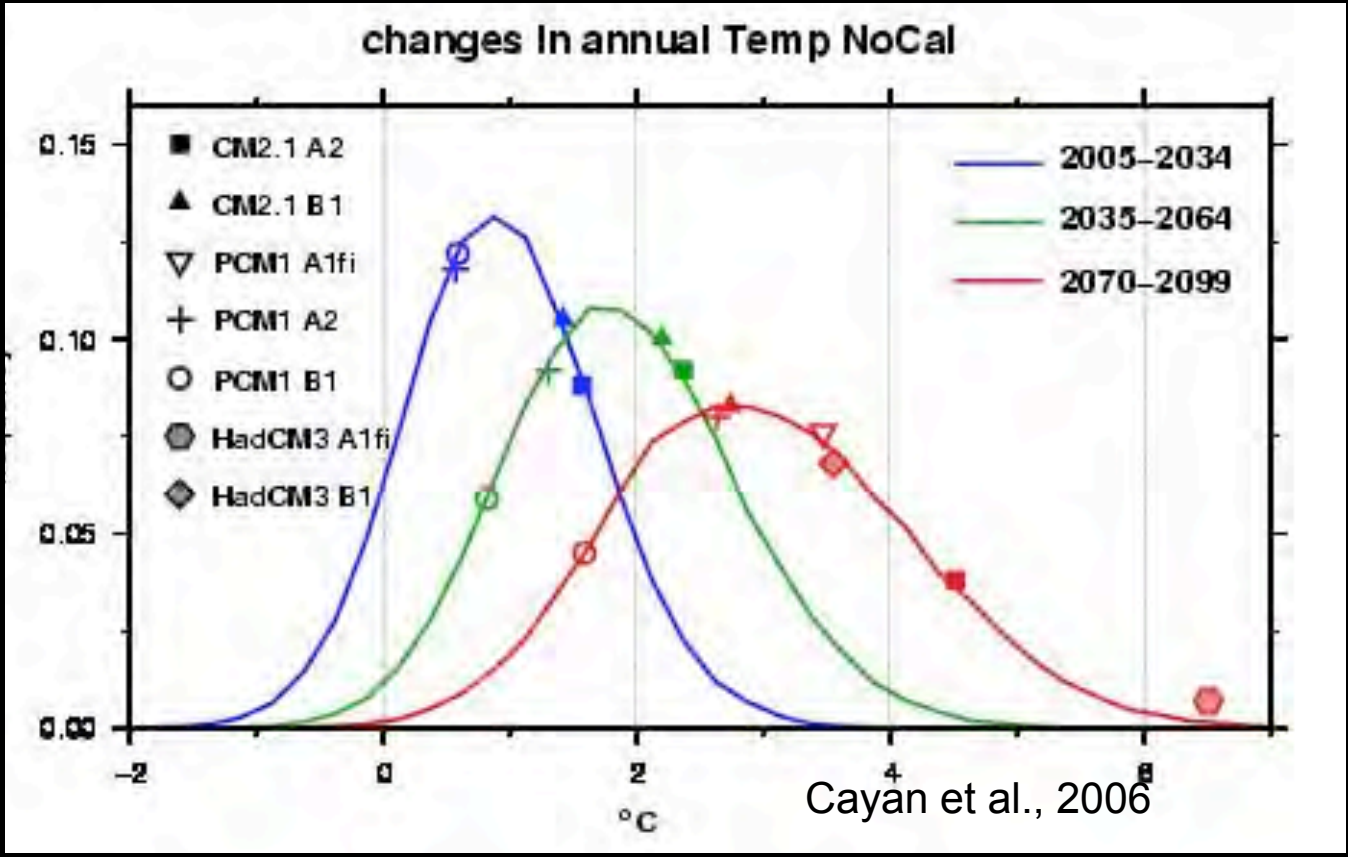
(to summarize when, where, & how much climate change is being projected)





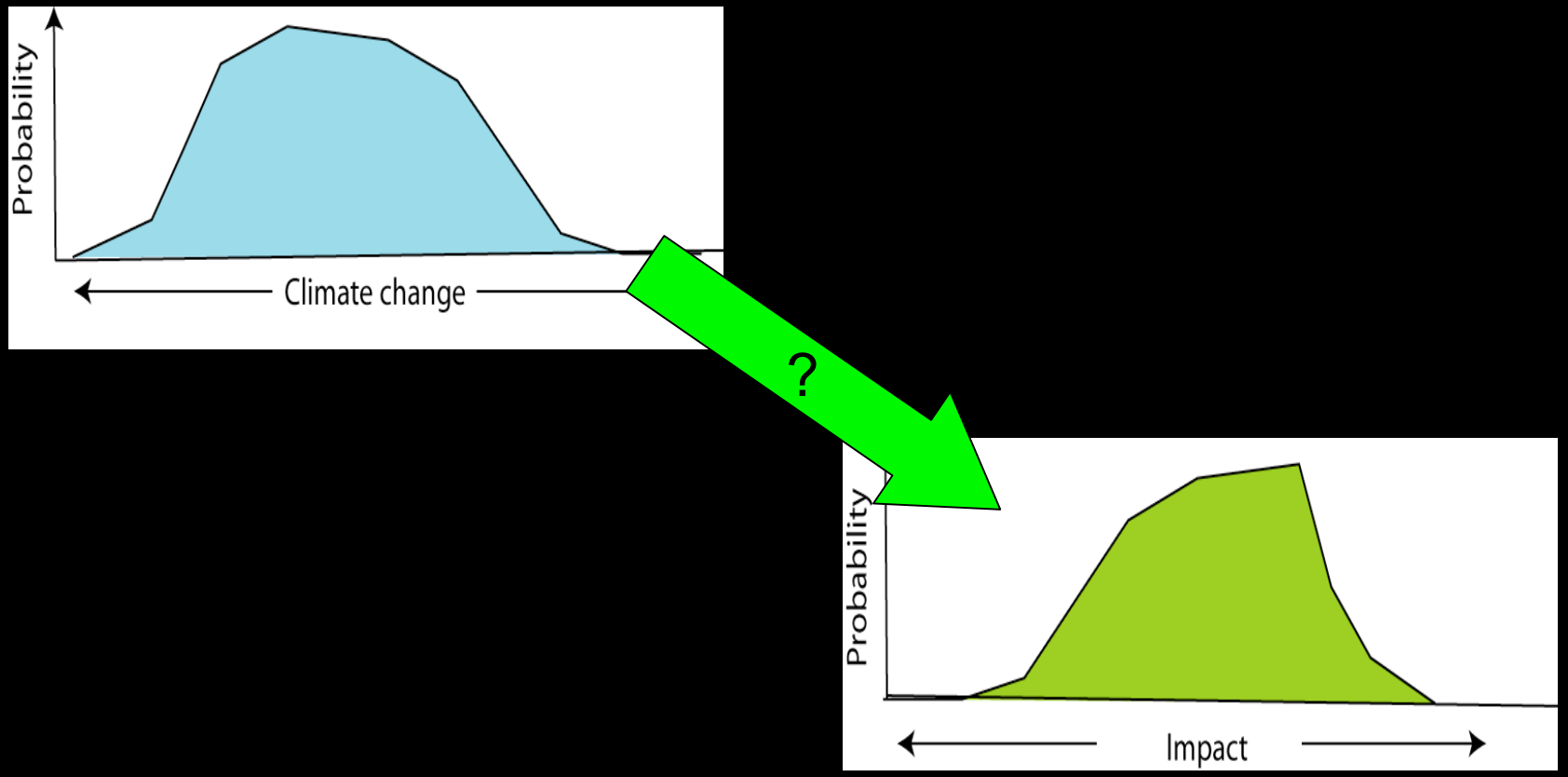


There is a LOT of information in these climate pdfs, both about the general distribution of projected changes and, more commonly, where the scenarios we analyze lie in the general range of projections…

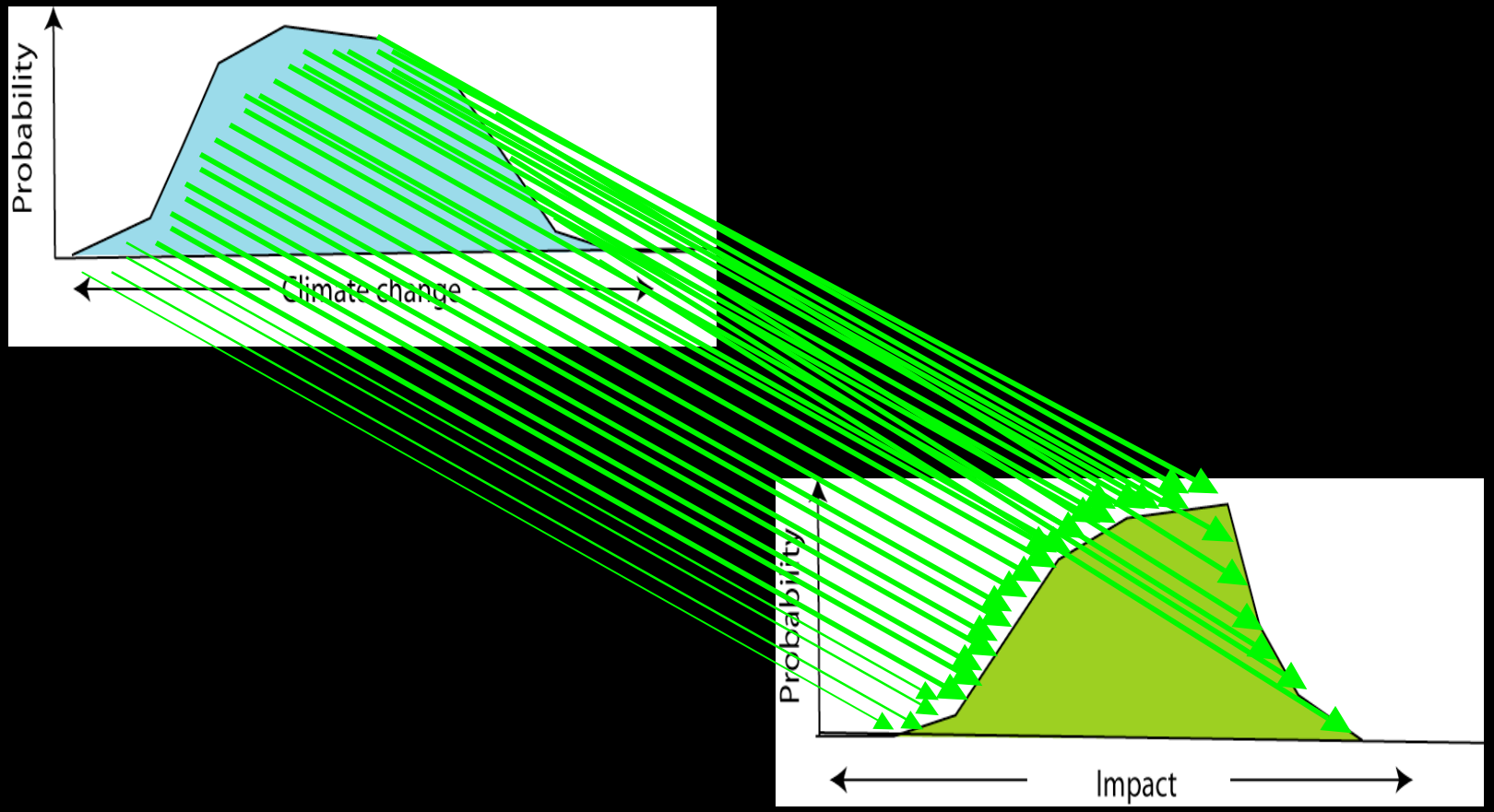


Cayan et al., 2006

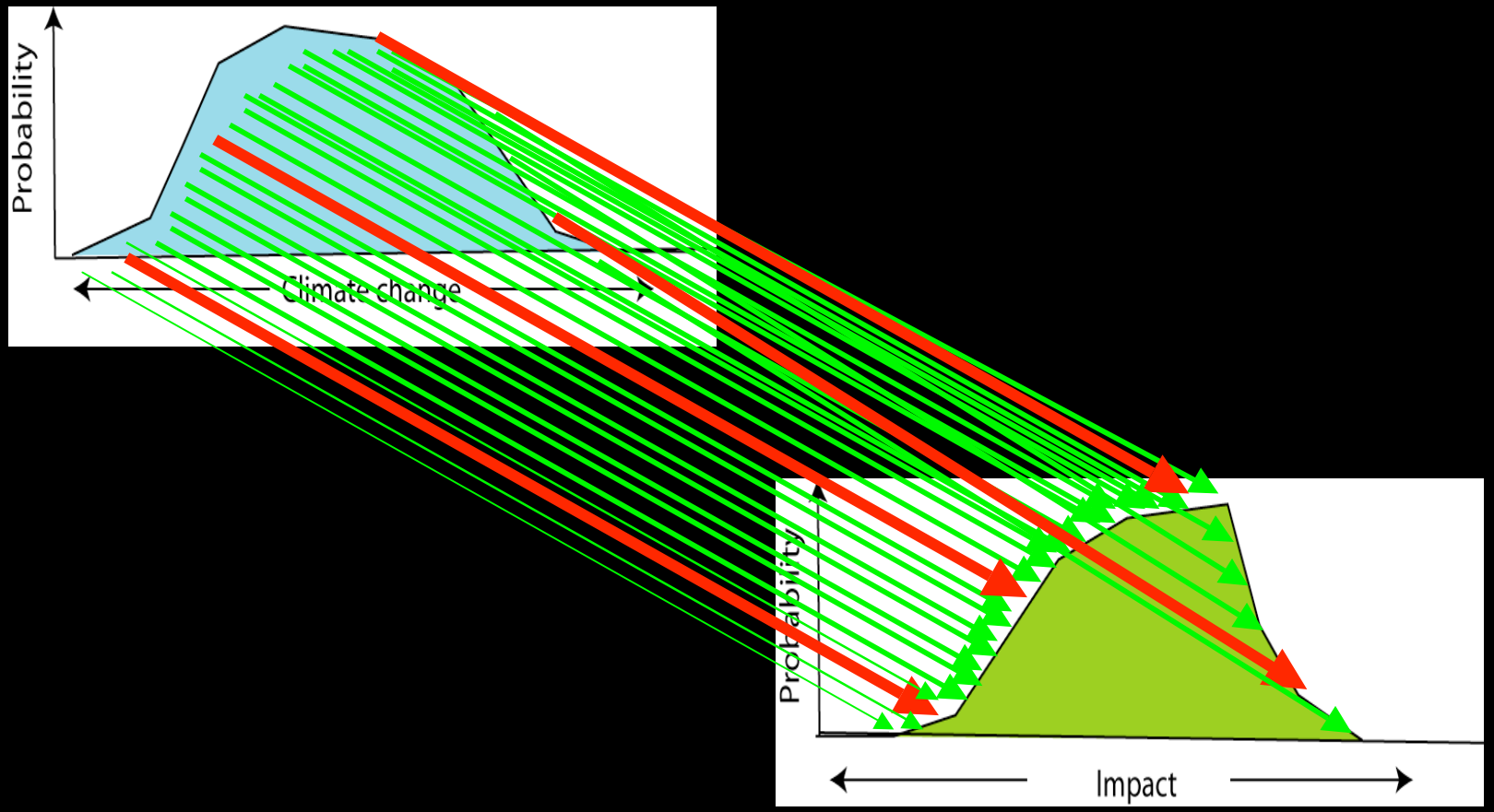
However, for most of us, what we really want to know is the probabilities of the IMPACTS of these climate changes…



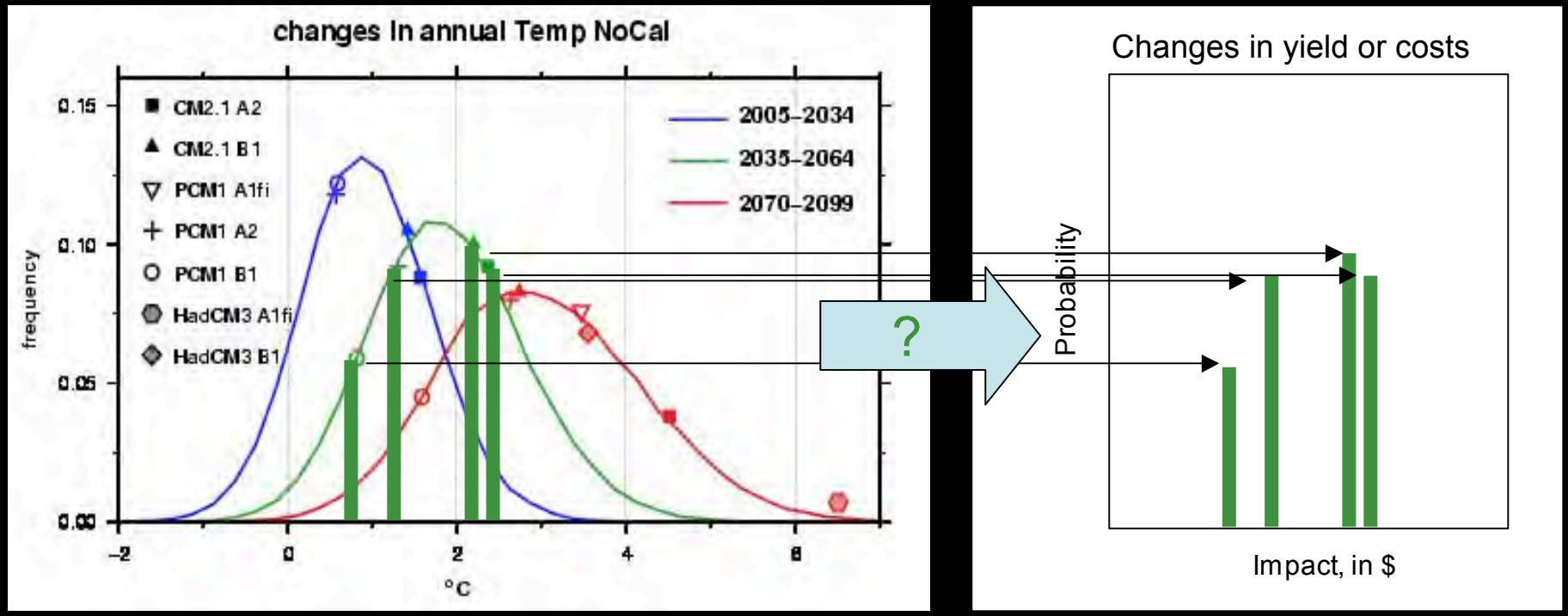
The most straightforward way to estimate the impact probabilities is to simulate the impact of every possible climate change and accumulate the frequency of various outcomes…



A much more common approach is to simulate the impacts of “representative” scenarios, in (implicit or explicit) hopes of inferring the impact probabilities *somehow*…

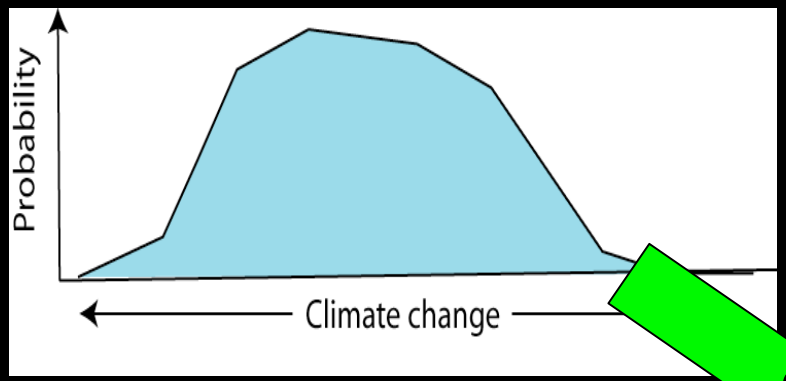


At first glance, it might appear that the impact probabilities would just be equal to the probabilities of the climate changes that generated the impacts….



That is: Can't we just label the impact estimates by the corresponding climate probabilities?

However, a basic finding in statistics, called "derived distributions", tells us that …



Prob(Impact) ≠ Prob(Climate)

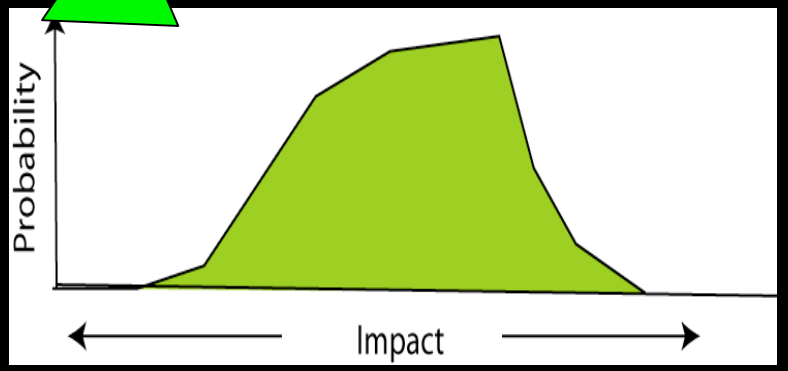
?

Instead…

Prob(Impact) =

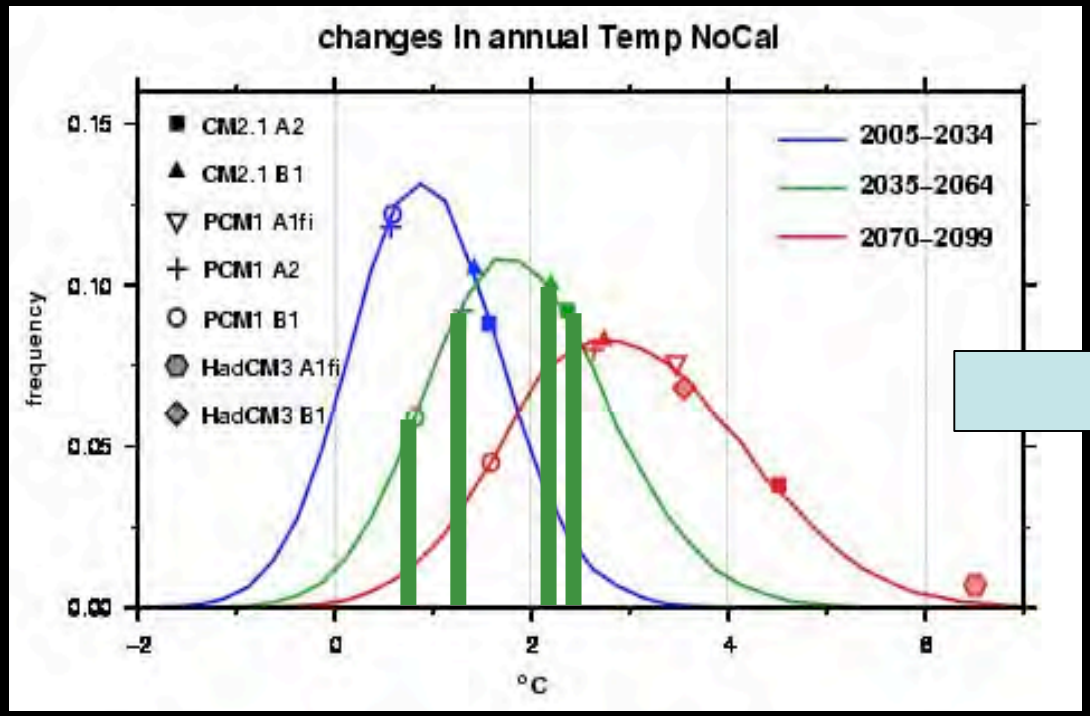
Prob(Climate) ÷

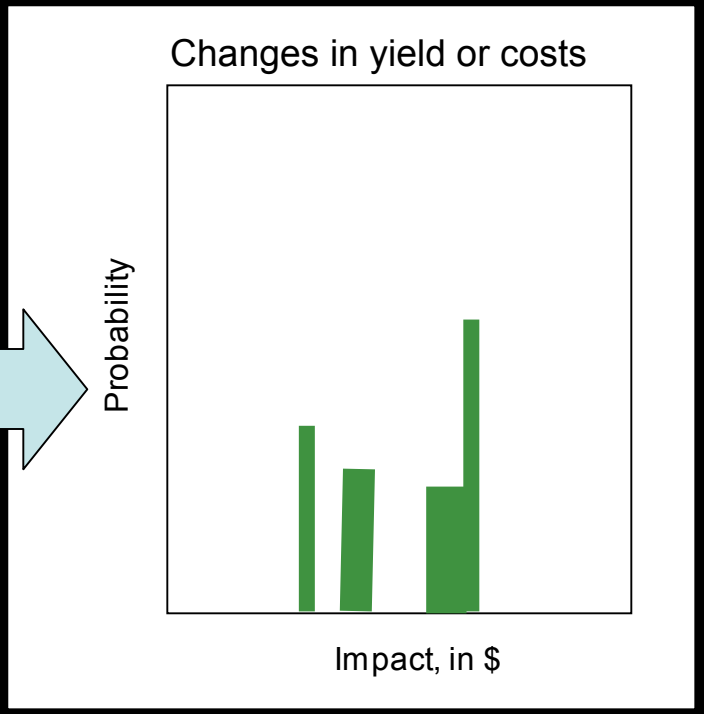
[dImpact / dClimate]



Prob(Impact) = Prob(Climate) / [dImpact / dClimate]

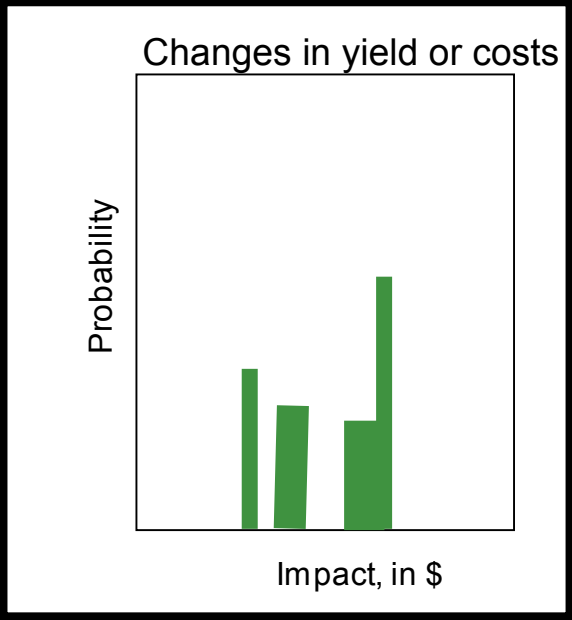
… means that the impact probabilities from climate changes in ranges where the impacts are more sensitive to climate get smeared out over a wider range of impacts, and vice versa for climate changes where impacts are less sensitive.





This has several implications for scenario-based studies:

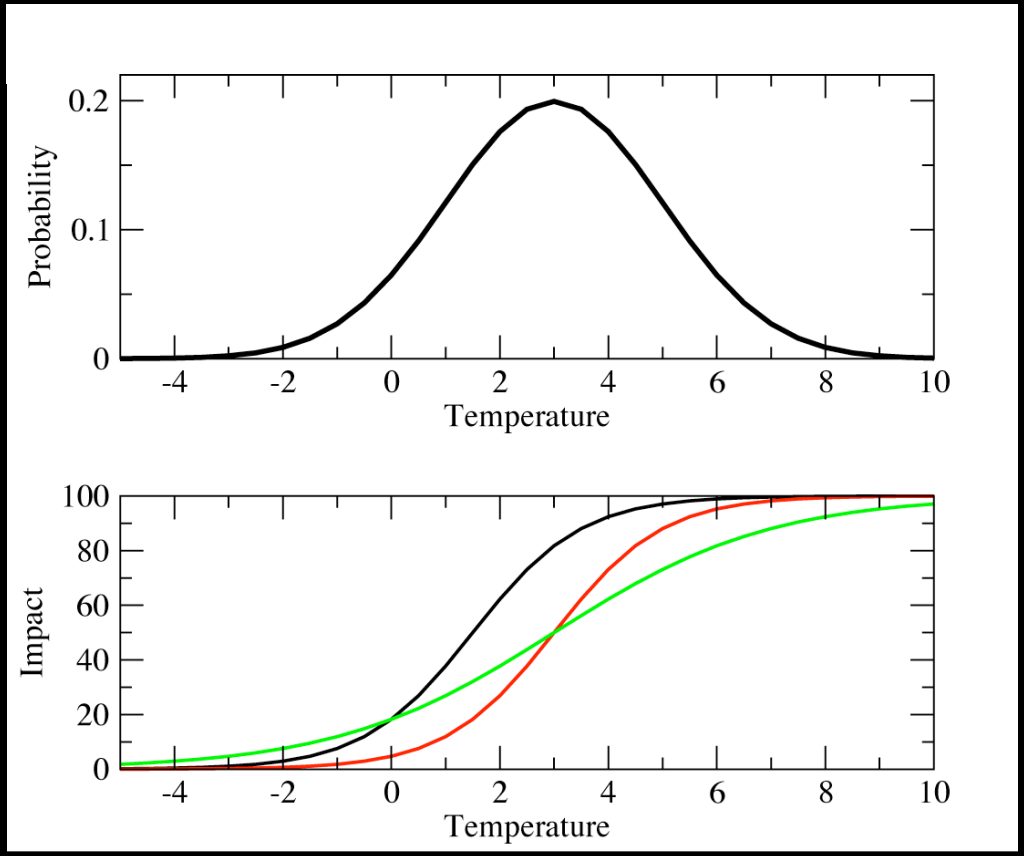
- Impact probability depends on how the impact depends on climate *AND* on what the odds of that climate change are.
- Probabilities estimated depend on the choice of scenarios.
- All choices of scenarios are not equally informative.
- Proper choice of scenarios allow accurate & EFFICIENT estimates of impact probabilities.



Impact probabilities depend on both climate pdfs & impact sensitivities

E.g., if the future distribution of temperature anomalies looks like this →

…and the impact (e.g., snowpack loss) depends on temperature anoms according to one of these curves →

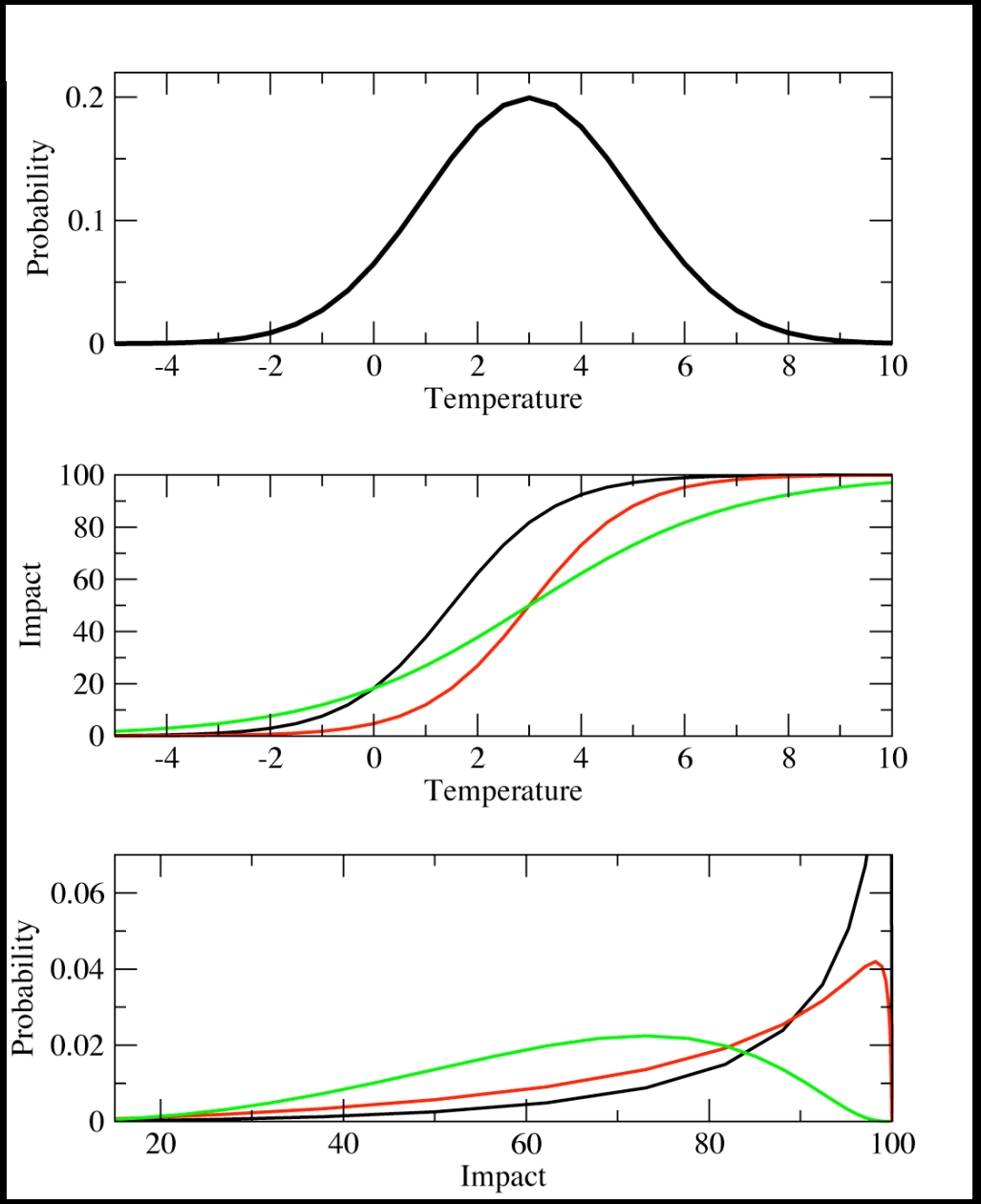


Impact probabilities depend on both climate pdfs & impact sensitivities

If the future distribution of temperature anomalies looks like this →

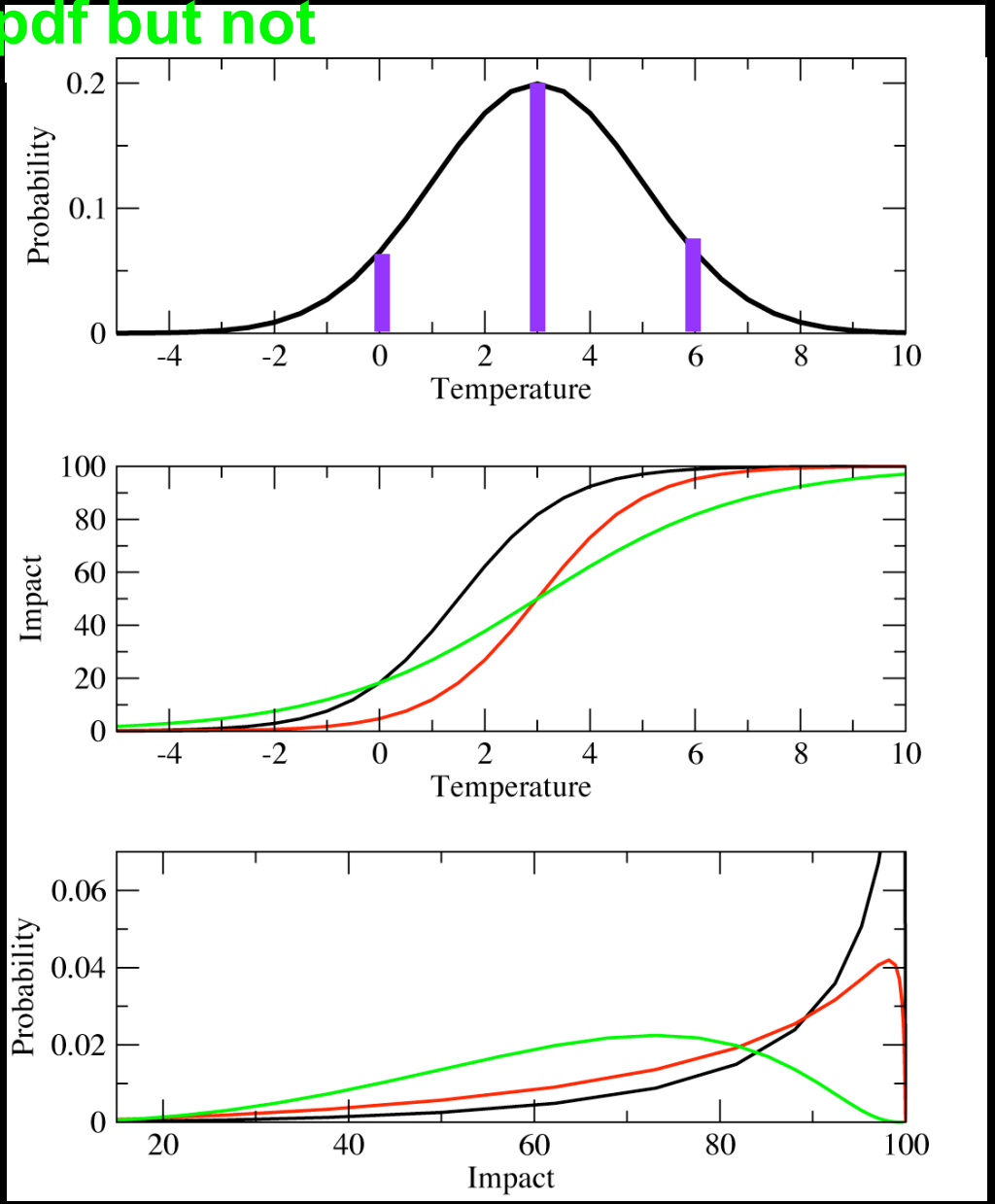
…and the impact (e.g., snowpack loss) depends on temperature anoms according to one of these curves →

…then the resulting impact pdfs would look like this →



Thus the same scenarios may adequately characterize one impact pdf but not another

A simple “bracketing” set of scenarios →

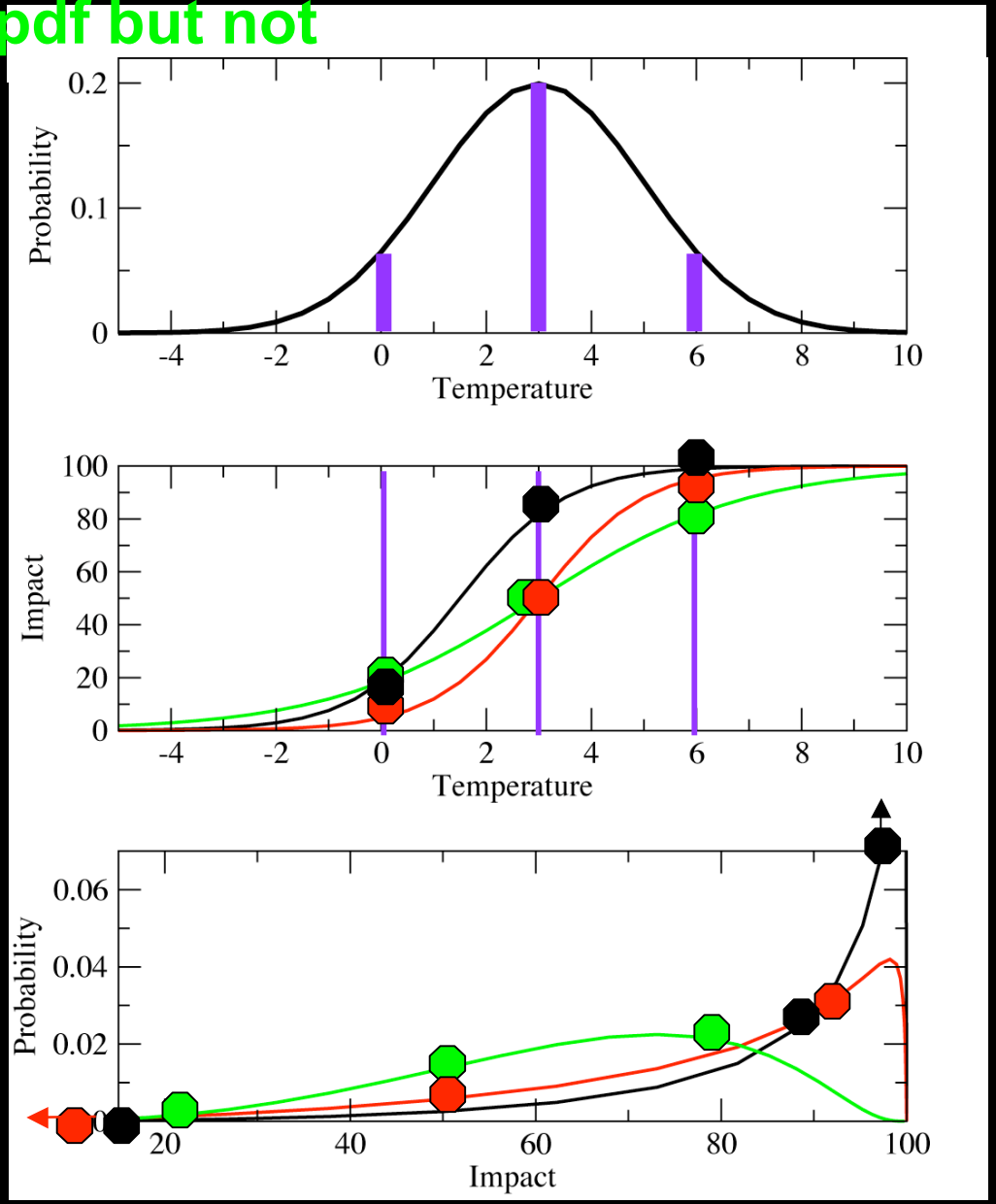


Thus the same scenarios may adequately characterize one impact pdf but not another

A simple “bracketing” set of scenarios →

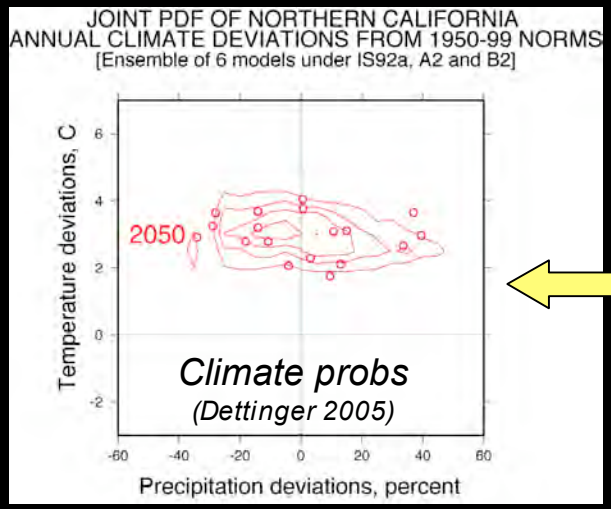
…samples different parts of the various impact curves →

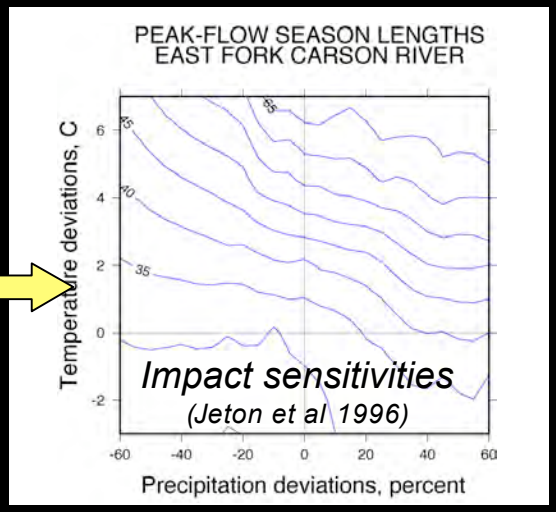
…thus providing a better description of some impact pdfs than others →



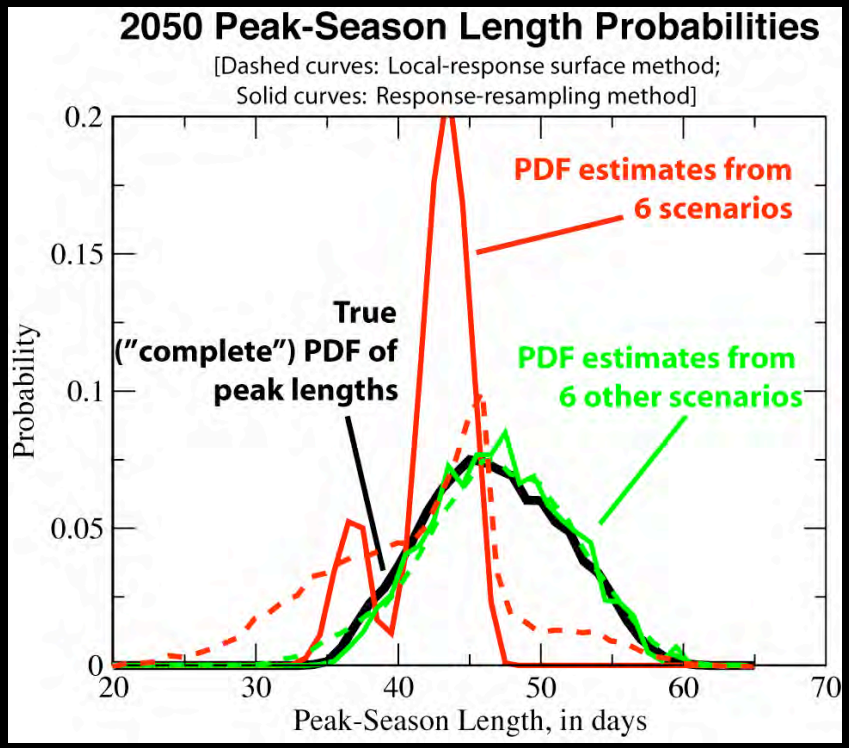
Some scenarios are more informative than others

Example: Using Northern Calif. climate-change pdfs, 2050, & measure of peak streamflow durations, Carson R





Estimates of impact pdf by applying two impact-pdf estimation methods to results from 6 scenarios each

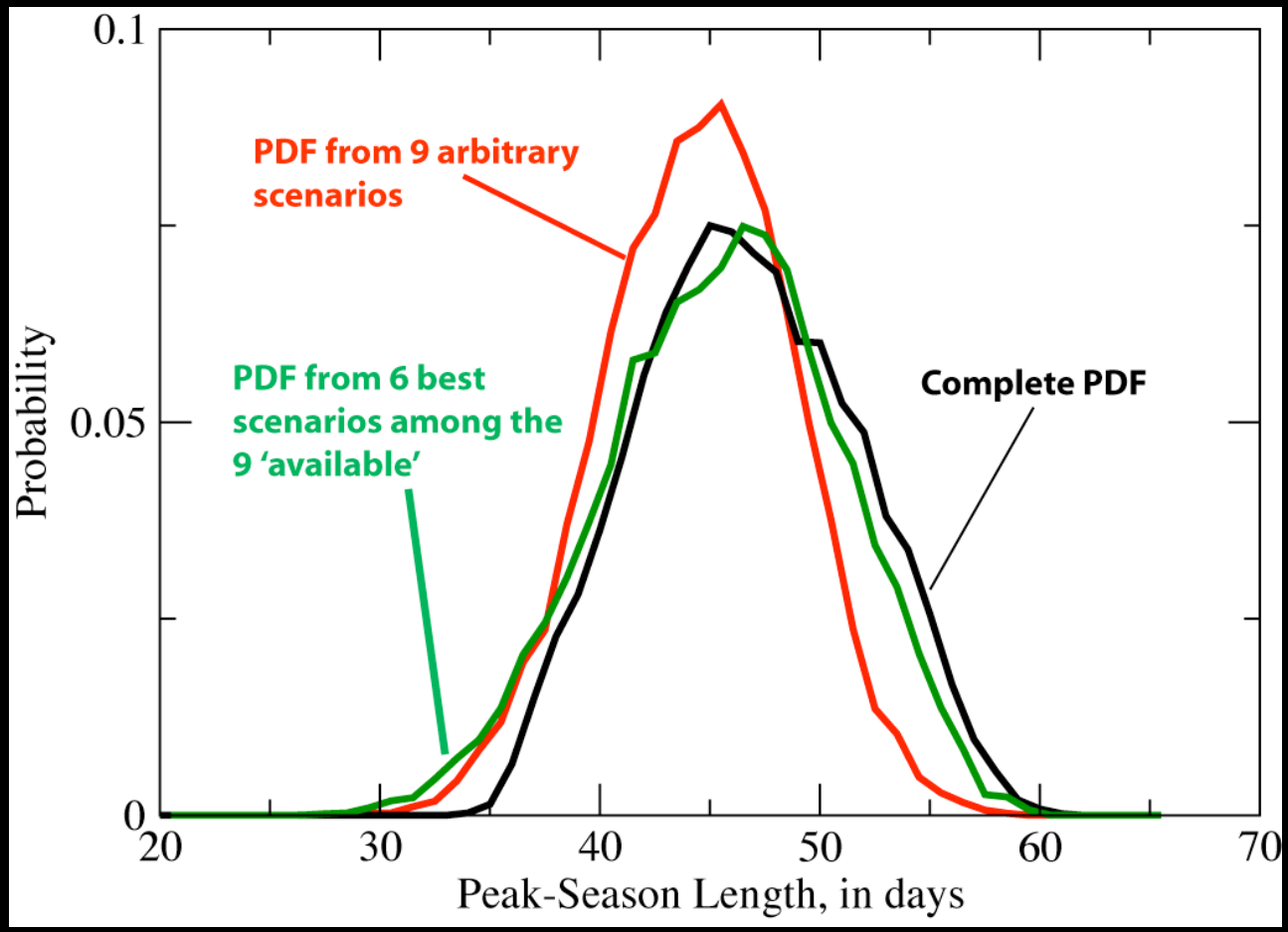


Dashed: Local-response surface method

Solid: Response-resampling method

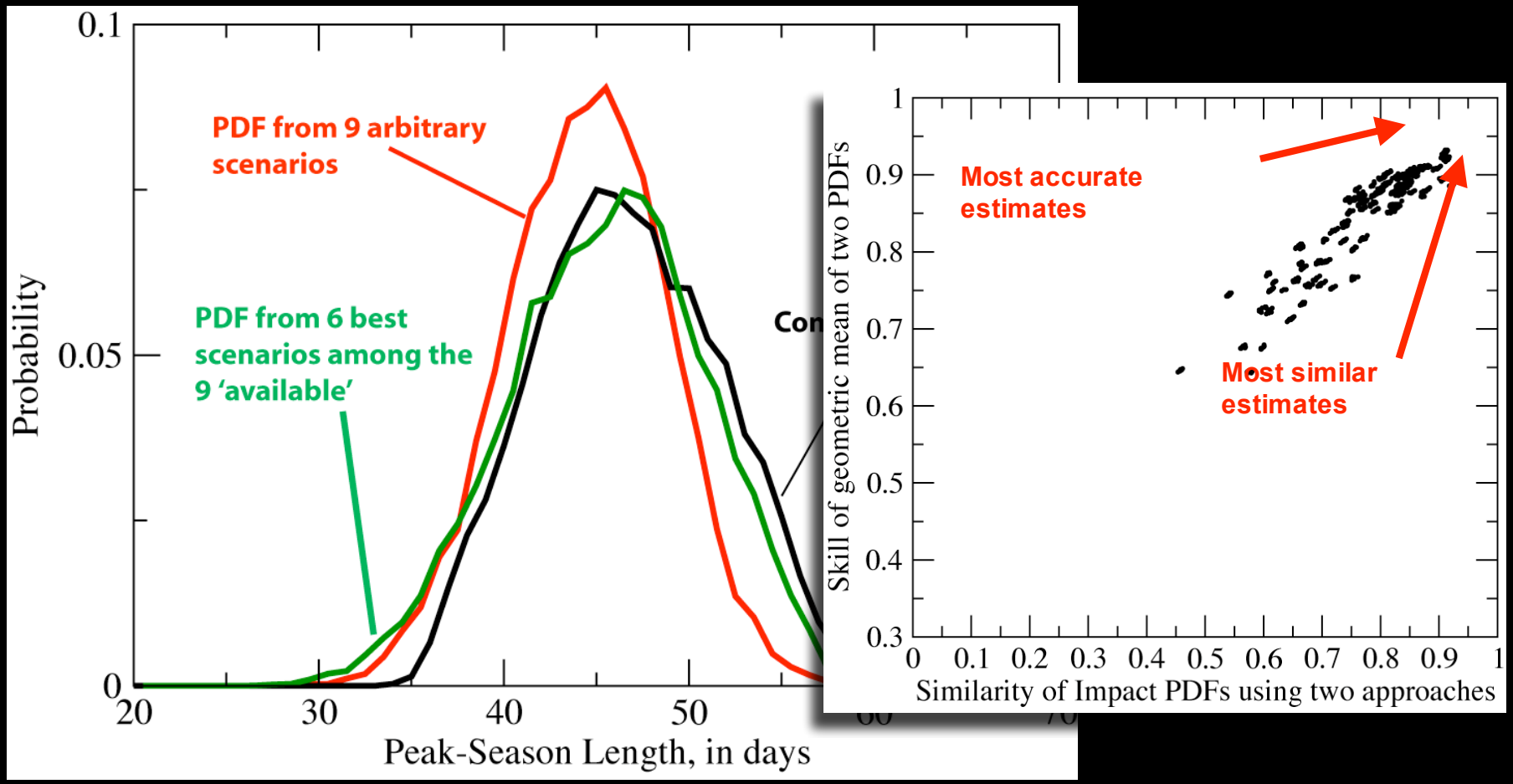
Proper choice of scenarios can provide accurate & EFFICIENT estimates of impact probabilities

The best impact-pdf estimates can be obtained by searching thru a limited number (9) of scenarios for a “best” subset (of 6) of scenarios...



Proper choice of scenarios can provide accurate & EFFICIENT estimates of impact probabilities

The best impact-pdf estimates can be obtained by searching thru a limited number (9) of scenarios for the subset (of 6) of scenarios that give the most similar pdf estimates by two separate methods.



CONCLUSIONS:

- *Impact probability depends on how the impact depends on climate AND on what the odds of that climate change are.*
- *Probabilities estimated depend on the choice of scenarios.*
- *All choices of scenarios are not equally informative.*
- *Proper choice of scenarios allow accurate & EFFICIENT estimates of impact probabilities.*

NEXT STEPS:

Simple examples in this talk; but working with Levi Brekke (USBR), Ed Maurer (SCU), Mike Anderson (DWR) & others on a USBR project that will allow me to test same concepts with full-blown ensemble of CALSIM scenarios.